

Mopalia kennerleyi Carpenter, 1864, a forgotten species and its southern analogue *Mopalia ciliata* (Sowerby, 1840)*

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Abstract: The hairy chiton *Mopalia kennerleyi* Carpenter, 1864 is distinguished from its congener *Mopalia ciliata* (Sowerby, 1840), and the identity of *Chiton wosnessenskii* von Middendorff, 1847 is clarified. *Mopalia kennerleyi* and *M. ciliata* are distinguished by setae structure, valve sculpture, and radular teeth. Their characteristics are illustrated and discussed, and their distributions defined.

Key words: chiton, sibling species, California, Polyplacophora, mollusc

The examination of several hundred lots of what has been regarded as *Mopalia ciliata* (Sowerby, 1840) from throughout its recorded range of Alaska to Baja California revealed that two similar but distinctive species could be distinguished by setae structure: *Mopalia ciliata* from southern California and Baja, and a northern species ranging from central California, north to the Aleutian Islands in Alaska, for which *Mopalia kennerleyi* Carpenter, 1864 appears to be the oldest available name. These distinctions in setae and name for the northern species have already been noted and illustrated by Eernisse *et al.* (2007). Recent molecular work by Kelly *et al.* (2007) and Kelly and Eernisse (2007) have clearly verified this conclusion.

It is not new to consider northern specimens as distinct. Pilsbry (1892: 305) distinguished *Mopalia ciliata*, from what he considered its variety *M. c. wosnessenskii* (von Middendorff, 1847), by the "much fainter sculpture" and by the latter's lack of "white thorns or spines (spicules) near the base of the setae." As Middendorff's name is currently regarded as a synonym of *M. ciliata*, one would first expect that this name should be revived for the northern taxon. However, an examination of the lectotype (Fig. 1; ZISP N834) (designated by Sirenko, pers. comm., October 2007), the larger of two syntypes of Middendorff's *Chiton wosnessenskii* (Fig. 1) revealed that it was instead a specimen of *Mopalia hindsii* (Sowerby MS, Reeve, 1847). The type locality for *C. wosnessenskii* is given as Atka Island in the Aleutians (52°11'57"N, 174°12'48"W); however, *M. hindsii* does

not occur in the Aleutians. Middendorff's type specimens were said to have come from both Atka Island and Sitka, Baranof Island, SE Alaska (57°08'N, 135°55'W), the Russian capitol of Alaska during the early 1800s and the type locality of many of Middendorff's types. Undoubtedly both specimens came from Sitka. The western-most distribution of *M. hindsii* is in the vicinity of Kodiak Island, in the Gulf of Alaska (57°N, 154°W). The question of name priority for these two nominal taxa is a matter for further investigation.

Pilsbry (1892) considered *Mopalia kennerleyi* Carpenter, 1864 to be a synonym of *Mopalia ciliata*, an assignment followed by Burghardt and Burghardt (1969), Smith (1977), and Kaas and Van Belle (1994).

Although the type of *Mopalia kennerleyi* is lost (Smith 1977, T. Nickens, USNM, pers. comm. October 2003), there can be little doubt from Carpenter's original description and the type locality of "Puget Sound" as to which species he was referring. *Mopalia kennerleyi* Carpenter, 1864 is thereby reinstated as the oldest available name for northern species.

MATERIALS AND METHODS

Specimens of "*Mopalia ciliata*" from my own collection, comprising more than one hundred lots from the Aleutian Islands to Baja California, were separated into two distinctive types of girdle setae using a dissecting microscope (as in Clark 1991). Setae and radula from each of these two potential species were prepared and examined with a scanning electron microscope (SEM) at the Biology Department of Southern Oregon University, using methods described by

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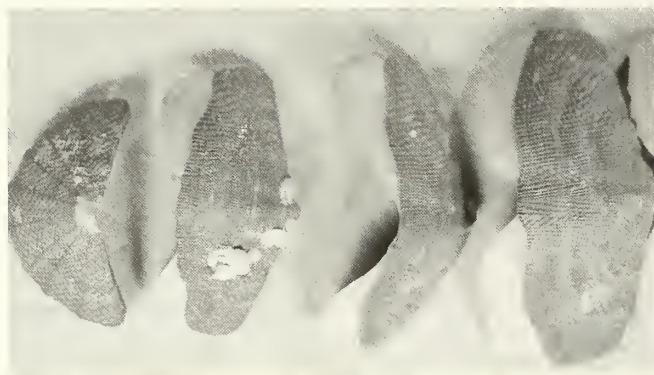


Figure 1. *Chiton vosnessenskii* von Middendorff, 1847. Lectotype, ZISP N834.

Clark (1994). The extensive collections at the Los Angeles County Museum of Natural History, California Academy of Sciences, San Diego Natural History Museum, Santa Barbara Museum of Natural History, and the Royal British Columbia Museum were also examined. The higher level systematics used here follows Sirenko (2006).

Acronyms used in the text are as follows: ZISP, Zoological Institute, Academy of Sciences, Saint Petersburg; LACM, Los Angeles County Museum of Natural History; RNC, Roger N. Clark, personal reference collection.

SYSTEMATICS

Class: Polyplacophora Gray, 1821

Order: Chitonida Thiele, 1910

Suborder: Acanthochitonina Bergenhayn, 1930

Family: Mopaliidae Dall, 1889

Genus: *Mopalia* Gray, 1847

Type Species: *Chiton hindsii* Sowerby, MS, Reeve, 1847, by subsequent designation.

Mopalia ciliata (Sowerby, 1840)

Mopalia kennerleyi Carpenter, 1864

Mopalia kennerleyi Carpenter, 1864

(Figs. 2-6)

Mopalia kennerleyi Carpenter, 1864: 648; Eernisse *et al.* 2007; Kelly and Eernisse 2007; Kelly *et al.* 2007.

Mopalia grayii Carpenter, 1864: 603 (*nom. nud.*).

Chaetopleura thouarsiana de Rochebrune, 1882: 191.

Mopalia ciliata var. *wosnessenskii* (Middendorff): Pilsbry, 1892: 305; Leloup 1942: 49.

Mopalia muscosa kennerleyi Carpenter, 1864; Dall 1921: 195; Oldroyd 1924: 197; Oldroyd 1927: 306.

Mopalia ciliata wosnessenskii (Middendorff): Abbott 1974: 305.

Mopalia ciliata (Sowerby): Burghardt and Burghardt 1969: 26 (in part); Smith 1977: 250 (in part); Putman 1980: 122 (in part); Baxter 1987: 105; Kaas and Van Belle 1994: 222 (in part).

Diagnosis

Medium sized (to 6.5 cm), oval chitons; valves subcarinated to rounded, depressed to moderately elevated, weakly sculptured. Girdle with strap-like or trough-shaped setae, bearing two rows of pointed spicules to about 250 μ m in length. Valves variously patterned with green, black, brown, yellow, red, and white.

Description

Chitons of medium size, neotype designated herein (Fig. 2) 49 $\times$ 27.5 mm; shell oval, subcarinated to rounded, low to

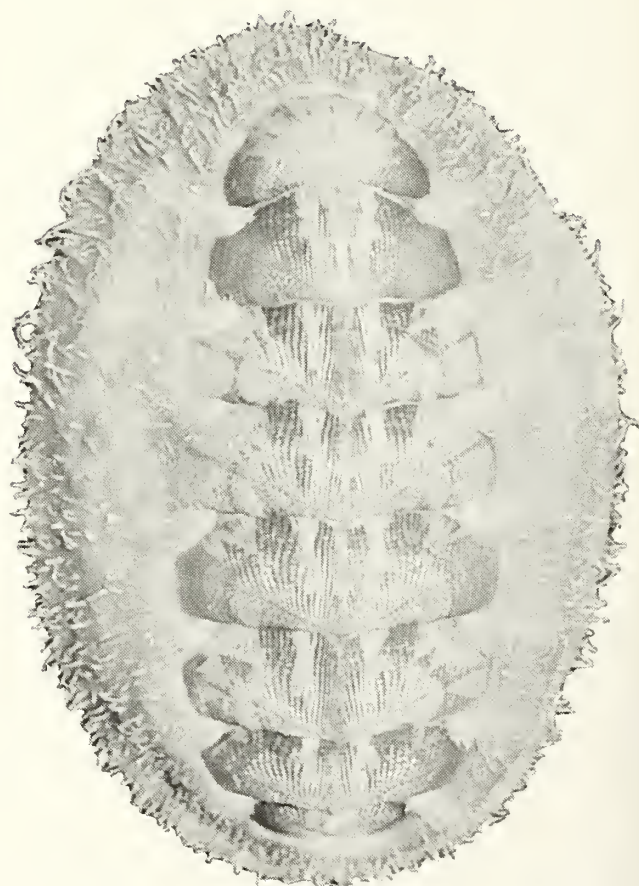


Figure 2. *Mopalia kennerleyi* Carpenter, 1864. Neotype, LACM 2886. Scale bar = 10 mm.

moderately elevated, beaked. Head valve and lateral areas of intermediate valves defined with rows of low, weak, flattened pustules; interstices of head valve and surface of lateral areas with radial rows of low, broad pustules, often coalescing into irregular zigzagging costae; central areas with smooth to granular, longitudinal (gently, posteriorly curved) ribs, or rows of low, coalescing, oval pustules. Tail valve small, oval, about twice as wide or more than long, with distinctive wide posterior sinus.

Girdle wide, usually more than one half the width of intermediate valves, notched posteriorly; dorsal surface bearing short (2-3 mm), slender trough-like or flattened (strap-like) setae (Figs. 3-5) with (normally) two rows of slender, curved, sharp spicules to about 250 μm in length (Figs. 4-5); ventral surface of girdle covered with minute, broad, flattened, distally pointed spicules to about $125 \times 34 \mu\text{m}$; margin of girdle with similar, but longer spicules, to about 180 μm .

Radula (Fig. 6), typical of a member of Mopaliidae, with large, robust major lateral teeth, bearing tridentate denticle caps; central cusp the longest, inner cusp slightly shorter, and outer cusp only about one third as long as the central; central tooth subquadrated, tapering proximally, and indented slightly just below cutting edge.

Ctenidia merobranchial, abanal, extending about 80% of foot length, from beneath valve two to the suture of valves seven and eight; about 42 per side in animals 50 mm in length.

Color: Valves variously patterned (Figs. 7-12) with green, brown, yellow, black, red, and white, often variegated, mottled, or suffused. Entire valves or portions one or more valves often unicolored. Girdle yellowish or brown.

Type material

Type lost (Smith 1977); NEOTYPE, LACM 2886 (*leg.* S. R. Thorpe, 1 July 1965) (Fig. 2).

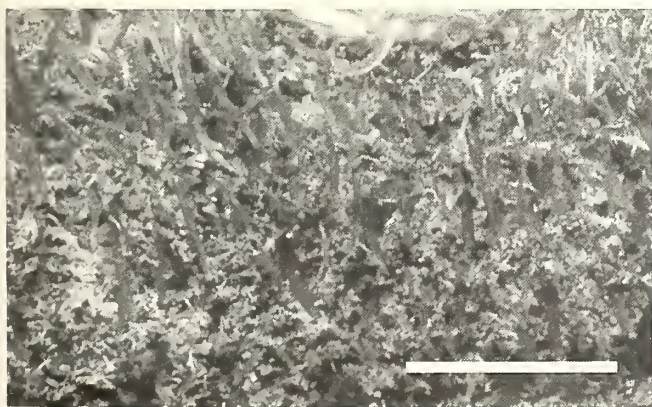


Figure 3. *Mopalia kennerleyi*. Close-up of girdle. Scale bar = 3 mm.

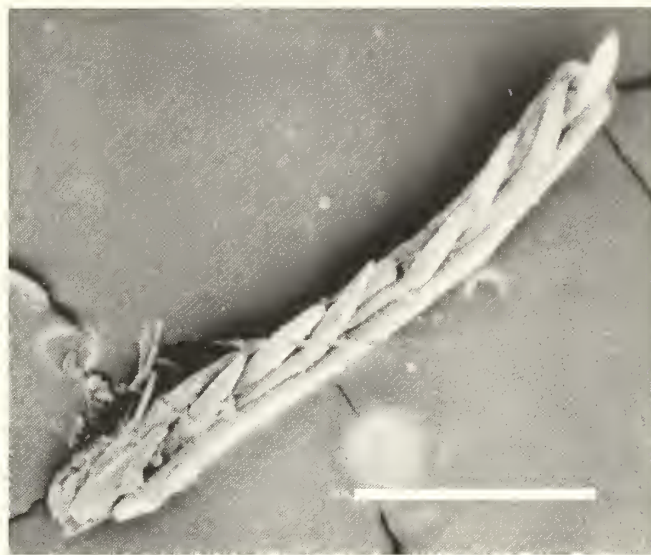


Figure 4. *Mopalia kennerleyi*. SEM image of seta. Scale bar = 250 μm .

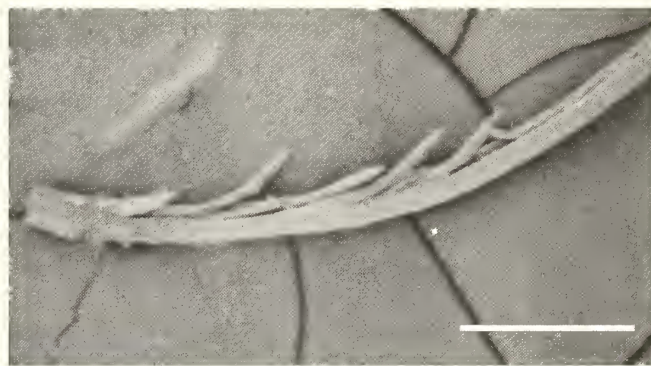


Figure 5. *Mopalia kennerleyi*. SEM image of seta. Scale bar = 250 μm .

Type locality

"Puget Sound", herein restricted to Tacoma Narrows, Pierce County, Washington, U.S.A. ($47^{\circ}16'N$, $122^{\circ}31'W$), intertidal.

Distribution

Mopalia kennerleyi is a North American boreal species, occurring from the southern Bering Sea (to about $54^{\circ}N$) and Aleutian Islands (west to Attu Island, $173^{\circ}14'E$; LACM 79-72) and Gulf of Alaska (north to $61^{\circ}N$) south to Monterey Bay, California ($36^{\circ}36'N$; RNC 1988), but rare south of San Mateo County, California ($37^{\circ}10'N$), where it begins to be replaced by the similar *Mopalia ciliata*. In Monterey Bay it is always subtidal, at about 10-15 m.

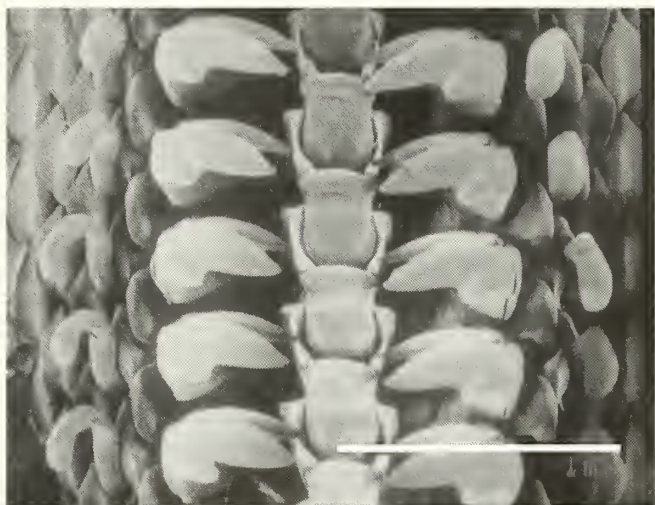


Figure 6. *Mopalia kennerleyi*. SEM image of radula. Scale bar = 500 μ m.

Mopalia ciliata (Sowerby, 1840)
(Figs. 7-10)

Chiton ciliata Sowerby, 1840: 289

Mopalia ciliata (Sowerby): Pilsbry 1892: 303; Leloup 1942: 49; Burghardt and Burghardt 1969: 26 (in part); Abbott 1974: 401; Putman 1980: 122 (in part); Clark 1991: 312; Kaas and Van Belle 1994: 222 (in part); Eernisse *et al.* 2007; Kelly and Eernisse 2007; Kelly *et al.* 2007.

Diagnosis

Medium sized (to 5.0 cm), oval to elongate-oval chiton; valves carinated, moderately elevated, finely sculptured. Girdle with short, strap-like setae bearing (normally) four rows of large, white, pointed spicules. Color variable, often suffused or mottled with pale green, white or dark brown, sometimes olive, with white, orange, red, and blue markings.

Description

Chitons of medium size, neotype $46 \times 28 \times 8$ mm (Fig. 7). Shell elongate-oval, valves carinated, moderately elevated, beaked. Head valve and lateral areas of intermediate valves defined with radial rows of fairly heavy, round or irregular pustules; interstices of head valve and surface of lateral areas with large, low, round or irregular pustules, which may be spaced or touching; posterior edge of lateral areas dentated by oval pustules; central areas with longitudinal rows of low, oval pustules or smooth ribs. Girdle moderately wide, about 1/2 to 3/4 the width of valves, notched posteriorly; dorsal surface spiculate, spicules to about 250×25 μ m, occurring (mostly) singularly, or in groups of two to four, as well as

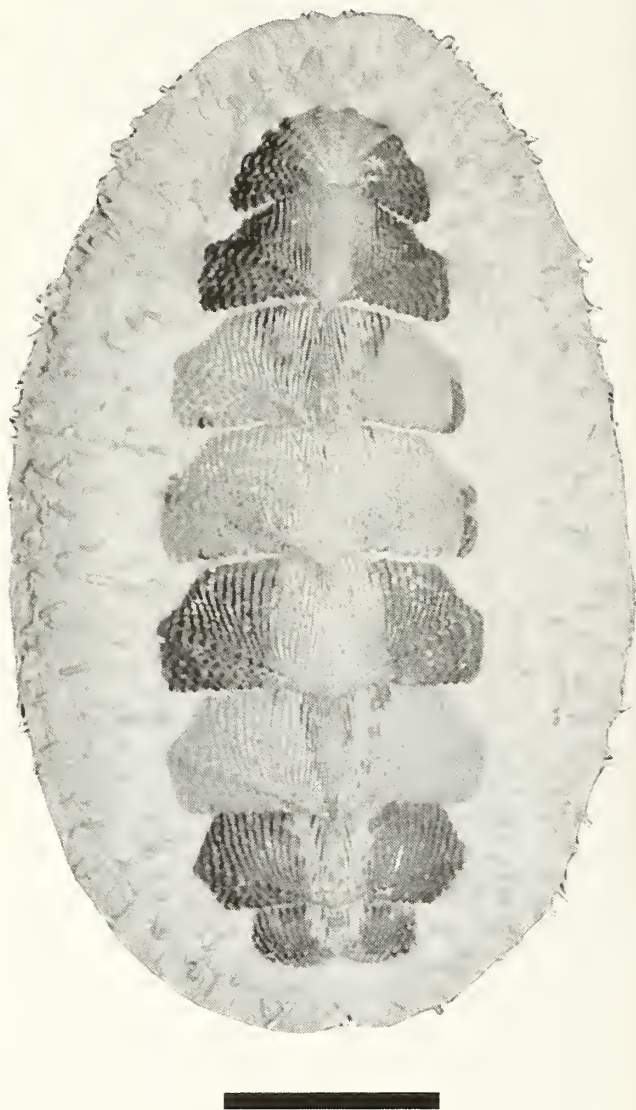


Figure 7. *Mopalia ciliata* (Sowerby, 1840). Neotype, LACM 2885.

short (2-3 mm), strap-like setae (Figs. 8-9) bearing four rows or robust, white spicules, to 600 μ m in length (often present only on lower half of seta); ventral surface of girdle with scattered spicules to 150×32 μ m; margin of girdle with similar but longer spicules to about 250 μ m. Radula (Fig. 10), with robust major lateral teeth bearing tridentate denticle caps; central cusp longest, inner one slightly shorter, and outer cusp about 1/3 as long as the inner one. Ctenidia, merobranchial, abanal, extending about 80% of foot length, from about the suture of valves two and three, to the suture of valves seven and eight, 34 per side in neotype.

Color: Variable, neotype green with black-brown markings. This according to Pilsbry (1892) is the "typical" coloration of the species, based presumably on Pilsbry's exami-

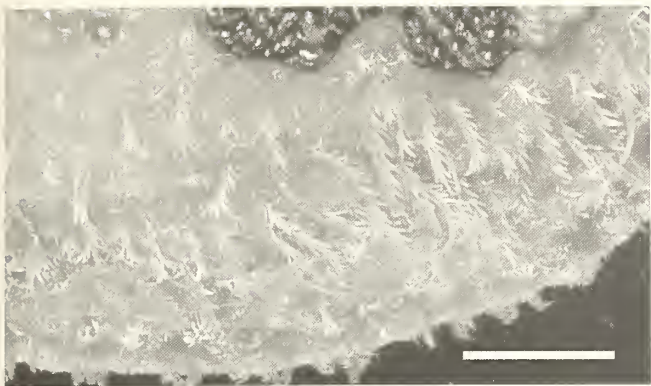


Figure 8. *Mopalia ciliata*. Close-up of girdle. Scale bar = 3 mm.

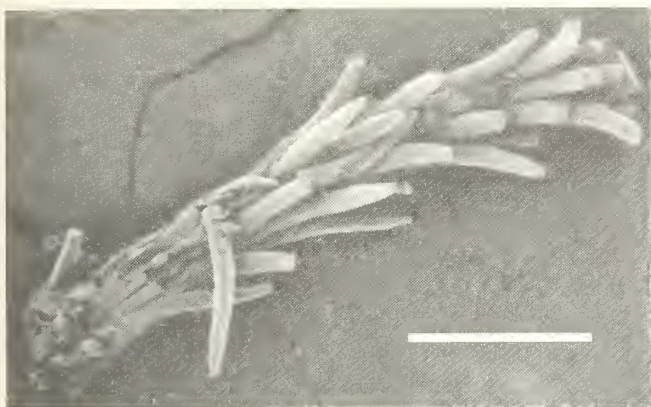


Figure 9. *Mopalia ciliata*. SEM image of setae. Scale bar = 500 μ m.

nation of Sowerby's material or original description. From the material examined, this is the typical color morph of southern California (Los Angeles and Orange Counties) populations.

Type material

Type, BMNH? Not located (K. Way, *in lit.*, 26 July 2000). Presumed lost. NEOTYPE, LACM 2885 (*leg.* Spencer R. Thorpe, Jr., low intertidal on rock, 11 December 1958).

Type locality

White Point, Los Angeles County, California, U.S.A. (33°42.8'N, 118°08.3'W).

Distribution

Mopalia ciliata is a North American, warm-temperate species, occurring between latitudes 38°40'N (RNC 1308), Sonoma County, California and 30°20'N (LACM 66-3), Rancho Socorro, Baja California. The species is rare north of



Figure 10. *Mopalia ciliata*. SEM image of radula. Scale bar = 500 μ m.

San Mateo County, California (37°10'N), where it is mostly replaced by *Mopalia kennerleyi*.

DISCUSSION

Although Pilsbry (1892) separated these two taxa as subspecies (using von Middendorff's *Chiton wosnessenskii* for the taxon presently regarded as *Mopalia kennerleyi*) based on the large prominent, white spicules present on the setae of *M. ciliata* and absent in "*M. wosnessenskii*," recent workers have had much difficulty separating the two.

The similarities between these two species are remarkable, as they mimic each other in the form and sculpture of the plates, as well as their coloration. Hybrids are unknown in *Mopalia*; none of the other eighteen Pacific coast species exhibit this tendency. However, in central California, a few specimens have been found that indicate further investigation into the possibility of hybridization might be warranted.

Mopalia ciliata is particularly puzzling, exhibiting a myriad of forms, some with broad plates, some rather narrow, and the sculpture varying from delicate and nearly smooth to quite coarse. Additionally, many animals in the Monterey Bay area often resemble *Mopalia spectabilis* Cowan and Cowan, 1977, with greenish (olive to turquoise) plates marked with brilliant blue zigzag lines and red flecks, but they are easily distinguished from that species by the generally broader outline, and the structure of the setae.

The most diagnostic character for distinguishing *Mopalia ciliata* and *Mopalia kennerleyi* (as well as all other species of *Mopalia*) is the structure of the setae. A comparison of the

setae (best taken from the central portion of the girdle) reveals that the setae of *Mopalia ciliata* are flatter, broader, and bear (when fully mature) four rows of large, robust, sharp, curved, white calcareous spicules, to about 600 µm in length. The setae of *M. kennerleyi* are more slender, trough-shaped (often nearly tubular) and bear (when fully mature) two rows of slender, slightly curved, sharp spicules, similar to those in *M. ciliata*, but much smaller, reaching only about 250 µm in length. Another useful distinction is that the posterior valve margin has denticulations in *M. ciliata*; these are lacking in *M. kennerleyi*.

The radulae of the two species are very similar, the teeth are nearly identical in shape and proportion, but those of *Mopalia kennerleyi* are proportionally about 20% larger than those of *Mopalia ciliata* of the same size. Also the middle cusp of the denticle cap of the major lateral teeth is slightly longer in *M. kennerleyi*.

Taken together, these characters along with their geographic separation provide ample evidence that *Mopalia ciliata* and *Mopalia kennerleyi* are both valid species.

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